Space Weather Technical Forecast

Issued on Friday, 17 May 2024 at 00:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance of further X-class flares throughout. Chance of S1/Minor Solar Radiation storming Day 1 (17 May).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate activity with an isolated M1.0 flare observed at 16/0804 UTC, attributed to emanating from AR3685 (Ehi/Beta) close to the southeast limb. Any activity from Ex-AR3664 is now likely to be completely obscured as it has fully retreated onto the far-side. There are fourteen sunspots on the disc, one of which is unnumbered. AR3685 is the largest region on the disc and continues to emerge from the southeast limb. Another region is rotating across the southeast limb in close proximity to AR3685 and is currently classified as Hax/Alpha, but the limited viewing angle results in reduced confidence in this assessment. AR3683 (Dsi/Beta-Gamma) in the southwest and AR3679 (Esi/Beta-Gamma) in the southeast, are two other regions of modest magnetic complexity and have exhibited signs of growth and development over the past 24 hours. The other sunspot regions are generally smaller, simpler and stable, although some modest magnetic complexity is visible in AR3674 (Cao/Beta-Gamma) which lies close to the solar meridian.

A filament eruption was observed around 16/1645 UTC, the associated CME may have an Earth-directed component. It has been analysed and is currently being modelled by Enlil. Otherwise, no Earth-directed CMEs were identified in available imagery.

Solar Wind / Geomagnetic Activity: A CME arrival was observed at L1 around 16/0430 UTC, this from an uncertain source. Solar winds increased to 470-500km/s where they remained for much of the period. Wind speeds declined gradually from around 16/1200 UTC, returning to background levels by 16/2000 UTC and are currently around 380 km/s. Interplanetary Magnetic Field (IMF), Bt, was initially weak at 5nT, but exhibited an erratic increase to peak at 17nT following the CME arrival. Values subsequently fell to weak levels and have remained steady around 7nT. The north-south component Bz was weakly negative initially, becoming more moderately negative following the CME arrival, peaking at -13nT at 16/0656 UTC. Since around 16/0930 UTC the north-south component has weakly fluctuated, but remained mostly positive. Phi angle was predominantly positive (away from the Sun), but with brief periods of negative (towards the Sun) phi angles, and was mostly negative 16/1500-2100 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3), but with a G2/Moderate geomagnetic storm interval recorded 16/0600-0900 UTC following the CME arrival, and a G1 Minor geomagnetic storm interval 16/0900-1200UTC. Activity then gradually declined back to Quiet levels (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) by GOES-18 was initially at S1/Minor Radiation Storm levels, but declined to slightly elevated levels around 16/1200 UTC and has since seen a slight decline. High energy electron flux (greater than 2MeV) observed by GOES16 was initially Moderate, peaking at 603 pfu at 16/0010 UTC before dropping to background, initially due to due to potential glancing CME arrival at 15/1814 UTC followed by a more significant drop following CME arrival beginning 16/0430 UTC. The associated 24-hour fluence has remained below the Active threshold and was on a steeply falling trend. Observed fluence at 17/0000 UTC of 7.28e6 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is now expected, with a slight chance of further X-class flares. These mainly from the new region close to the southeast limb which produced an X2.9 flare on 15 May. The rest of the regions currently on the visible disc are smaller and simpler, with isolated M-flares possible from these. A new region may rotate onto the northeast disc later Day 1 or Day 2 (17-18 May) with no other significant regions expected to return or rotate onto the disc during the period.

Solar Wind / Geomagnetic Activity: A glancing CME arrival is possible later Day 1 (17 May) from a filament eruption on the northeast disc on 14 May. Solar winds are expected to remain at background levels, but close to slightly elevated levels. Chance of some further enhancement from uncertain CME arrival. Activity is expected to be mainly Quiet (Kp 0-2) with Unsettled (Kp 3) intervals. Chance of an Active interval and a slight chance of a G1/Minor Geomagnetic storm intervals from any CME glances, mainly later Day 1 (17 May).

Energetic Particles / Solar Radiation: GOES-18 proton flux is expected to continue slowly easing, likely remaining below the S1/Minor radiation storm level. There is the potential for enhancements from any further significant flares from Ex-AR3664 on Day 1 (17 May), as the protons can still be directed towards Earth along the Parker Spiral. High energy electron flux reduced to background following CME arrival but forecast to rise once again into the period as CME influences eases, bringing a chance of Active fluence Days 2-4 (18-20 May), however this is low confidence due to uncertain CME arrival later Day 1.

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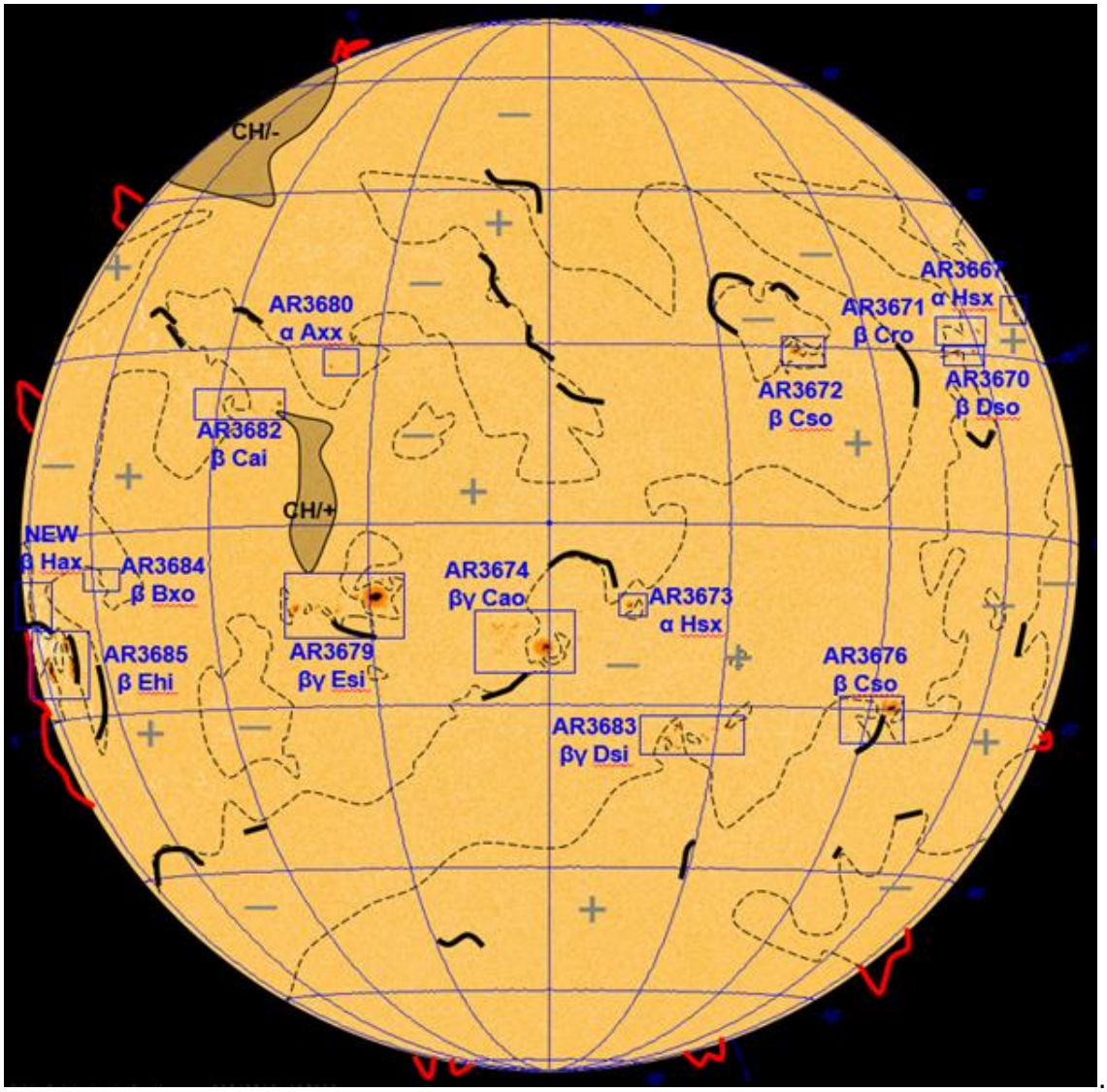
Figure 1. Solar Analysis Valid 16/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CMEs from Ex-AR3664 have now all passed Earth, with any further CMEs from this departed region expected to miss the Earth. There is the potential for a CME to partially arrive at Earth on Day 1 (17 May). This feature is associated with a filament eruption observed leaving the northeast disc on 14 May. While anticipated to pass largely north and behind Earth, glancing interactions are possible later Day 1, with associated enhancement potentially persisting overnight into Day 2 (18 May). A further filament eruption was observed leaving the northwest disc around 16/1645 UTC, modelling is currently underway for this feature with a possibility of any enhancement associated with this feature to affect Earth on Day 3 (19 May). This is low confidence however, with the feature yet to be modelled by MOSWOC Enlil.

Solar winds have returned to background levels with any influence from the recent CME arrival having waned. In the absence of further CME enhancements, winds are expected to remain at background levels, but close to slightly elevated levels (350-400 km/s) with no notable coronal holes expected. Solar winds may see moderate enhancement to 450-500 km/s should any CME arrivals occur, this most likely Day 1 into Day 2 (17-18 May).

Activity is expected to be mainly Quiet (Kp 0-2) with Unsettled (Kp 3) intervals. Chance of an Active interval and a slight chance of a G1/Minor Geomagnetic storm intervals from any CME glances, mainly later Day 1.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1526	Partial	Filament Eruption	NE	685 km/s	17/1800 UTC +/- 6hrs	Low confidence. Glancing blow.

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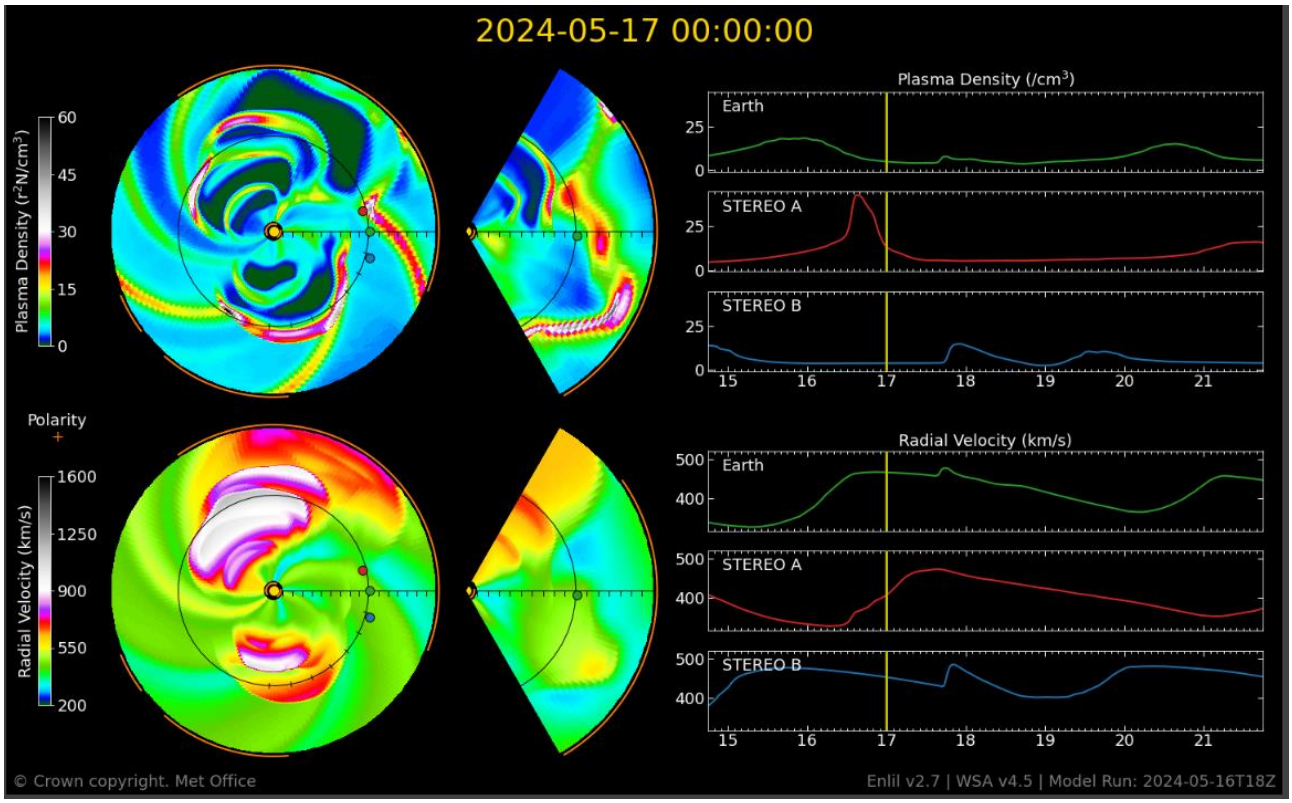
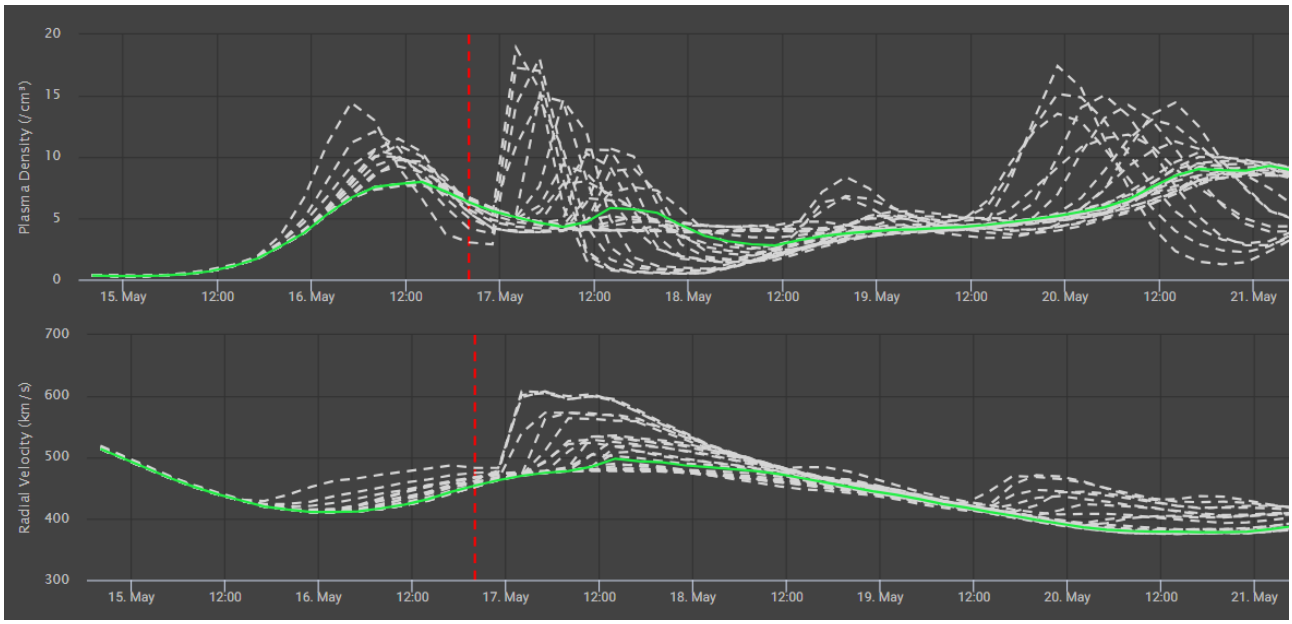
Figure 2: MOSWOC Enlil and Ensemble.





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Radio Blackouts - X-Ray Flares:
Low to Moderate activity is expected, but with a chance of further High activity. The large and complex region that continues to rotate onto the southeast disc is considered to be the most likely source for X-class flares, having produced an X2.9 flare on 15 May. This region is currently difficult to analyse due to the restricted viewing angle, with a fuller understanding of the flare risk likely later in the coming 24 hours as this region continues rotating onto the visible disc.
Recent activity has been dominated by the very active region Ex-AR3664, however this sunspot group has now moved onto the far-side with any subsequent activity increasingly unlikely to be visible from the Earth-side.

There are currently fourteen sunspots on the visible disc. The largest region on the disc is AR3685 (Ehi/Beta), which lies close to the southeast limb. This region is composed of a number of large spots which may be a closely connected collection of different regions, magnetic looping is visible across the region and as such it remains classed as one large sunspot group. A new region continues to emerge from the southeast limb, just to the north of AR3685. AR3683 (Dsi/Beta-Gamma) in the southwest and AR3679 (Esi/Beta-Gamma) are two other regions of modest magnetic complexity and having shown some signs of growth over the past 24 hours. The other sunspot regions are generally smaller, simpler and stable, although some modest magnetic complexity is visible in AR3674 (Cao/Beta-Gamma).

Other than the emerging unnumbered region in the vicinity of AR3685, a further region may rotate onto the disc later Day 1 or Day 2 (17-18 May). Other significant regions may approach the eastern disc by the end of the period. As such, the flare risks have been maintained.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: GOES16 & GOES18 X-Ray trace from past 24 hours

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Solar Radiation Storms - (High Energy Protons):
Recent S1/Minor Radiation Storm conditions were the result of the M6.6 flare of Ex-AR3664 on the southwest limb on 13 May and further contributions from the flaring of this region through 14-15 May, with at least four X-flares occurring.

Proton flux is expected to remain below S1/Minor storm levels, although there is a chance that should any large flares occur from Ex-AR3664 on Day 1 (17 May) that protons could be directed towards Earth through the Parker Spiral and produce some Minor radiation storming. While there are a number of small sunspot regions of the Earth-facing disc none of these are currently considered candidates for proton rich flares, with the potential for proton storms decreasing notably by Day 2 (18 May) as Ex-AR3664 moves further onto the far-side.

Radiation Storms	**Level (cm^{-2} sr^{-1} s^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ S1**	Yes	50	20	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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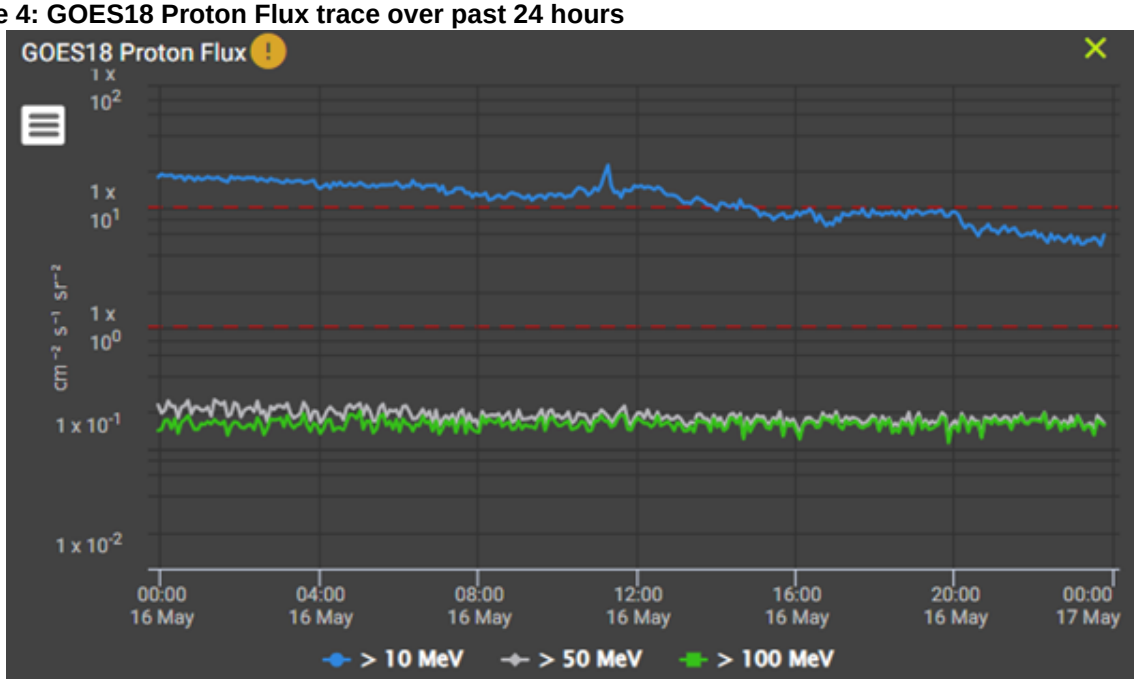
Figure 4: GOES18 Proton Flux trace over past 24 hours



High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 has initially at Moderate levels, but fell to background levels following the CME arrival early on 16 May. This trend is most likely to persist in the short term, however there is the potential for electron flux to rise and potentially reach persistently High levels, with lower orbits having been highly charged by CME arrivals over previous days. A continued rise in flux levels from later Day 1 (17 May) onwards is expected although confidence is reduced due to the potential for a glancing CME arrival later on Day 1 (17 May), which may again reduce the observed flux.

The associated 24 hour fluence is expected to see a general falling trend near term, before likely retuning to a rising trend later Day 1 (17 May) onwards, perhaps approaching or crossing the Active threshold Days 2-4 (18-20 May). MOSWOC REFM providing reasonable guidance Day 1 although perhaps under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	20	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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Figure 5: GOES16 Electron Flux trace over past 24 hours

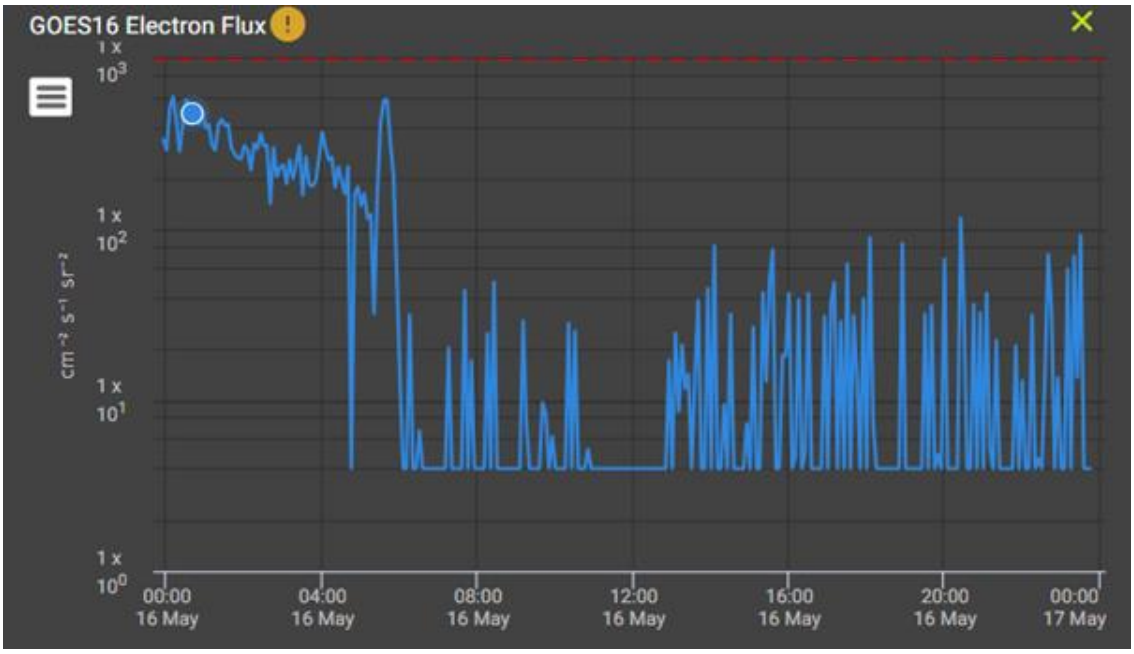
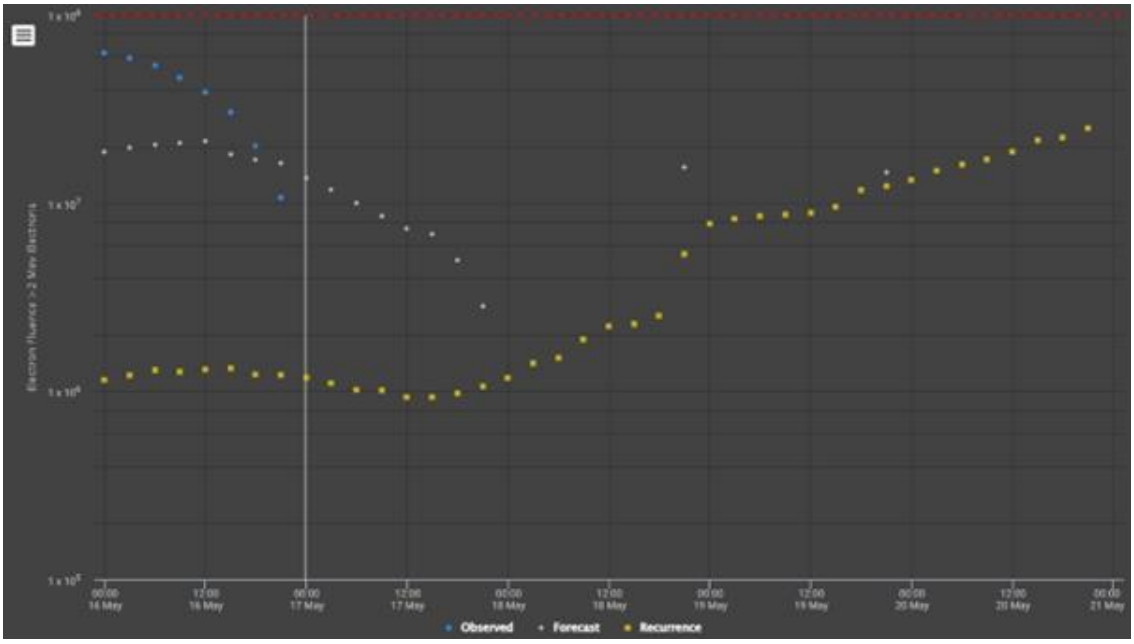


Figure 6: MOSWOC REFM considered to be giving good guidance but with values too low later in period.



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